# Chapter 8

# Republic of Korea Country Report

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## 1. Basic Concept of Low-carbon Energy Transition–Carbon Neutrality

The global effort to achieve net-zero carbon requires innovation in the energy sector. The energy sector accounts for approximately 75% of global carbon emissions. The main levers for the energy sector to achieve carbon neutrality are low-carbon energy transition and carbon neutrality (LCET–CN) including energy reduction through behaviour change, energy efficiency, clean energy, electrification, carbon capture, utilisation, and storage (CCUS), etc. Electrification, which increases the proportion of electricity in final energy consumption, is being considered by countries around the world as a major means of carbon neutrality.

The energy sector is the leading contributor to greenhouse gas (GHG) emissions, making the low-carbon energy transition a global trend since GHG emissions affect global warming and climate change, the most important issues globally. To achieve carbon neutrality in 2050, the overall structure of the energy sector needs to be transformed in addition to reducing the use of fossil fuels. Consequently, most countries are trying to transform their energy systems from the current fossil energy-oriented one to a sustainable green energy-oriented one rested on energy efficiency and renewable energy.

In this context, the Republic of Korea has established and implemented several basic plans and roadmaps including Energy Transition Roadmap, Energy Basic Plans, Renewable Energy Basic Plans, 2050 Carbon Neutral Strategy, Rational Energy Use Basic Plans, Electricity Supply and Demand Basic Plans, and Hydrogen Economy Revitalization Roadmap, to name a few. The government takes these basic plans and roadmaps as stepping stones to mobilise nationwide resources in relevant energy sectors to reduce carbon dioxide ($CO_2$) emissions in response to the historic Paris Agreement in 2015 as well as the global trend of energy transition to a sustainable energy system. Despite all these efforts and the government's commitment, that is not enough. In order to cost-effectively implement those plans supported by consensus amongst stakeholders and national participants, it would better be preceded or directly followed by technical as well as an economic feasibility analysis based on calculations of investment costs in terms of fuel costs, power generation, carbon capture and storage (CCS), etc.

## 2. Final Energy Consumption (historical trend: 2019, 2030, 2040, 2050)

This section discusses the LCET–CN scenario developed based on the combination of policy options including efficiency improvement, more efficient thermal power generation along with higher contribution of renewable energy and hydrogen, amongst others.

### Historical Trend

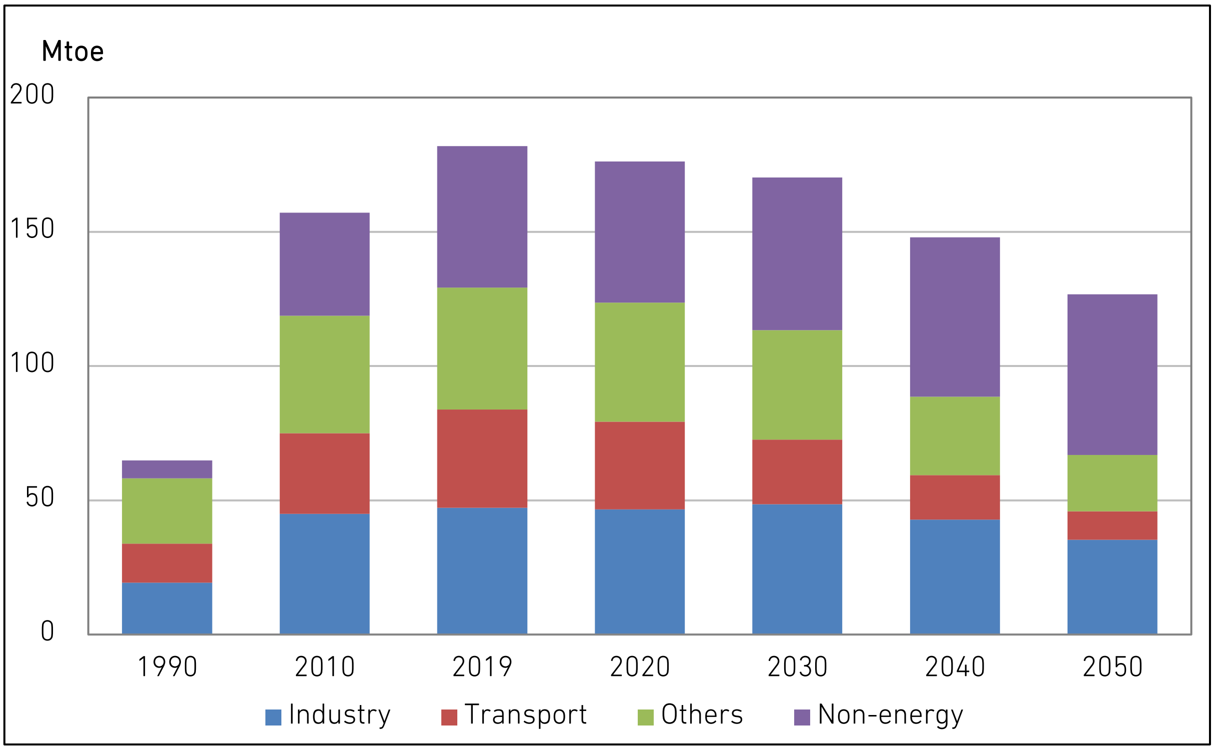
The Republic of Korea's final energy consumption grew 3.6% per year, from 64.9 million tonnes of oil equivalent (Mtoe) in 1990 to 181.9 Mtoe in 2019. The non-energy sector had the highest growth rate during this period at 7.4% per year, followed by the transport sector with 3.2%. Energy consumption in the residential/commercial/public ('others') sector grew at a relatively slow pace of 2.2% per year. Oil was the most consumed product, with a share of 67.3% in 1990, declining to 53.8% in 2019. The share of coal in the final energy consumption declined by 13.7 percentage points between 1990 and 2019, whereas the share of electricity nearly doubled, becoming the second-largest consumed product.

### LCET–CN Scenario

The total final energy demand in the LCET scenario is to be reduced to 126.7 Mtoe, decreased by 55.3 Mtoe or 30.4% from 181.9 Mtoe in 2019 at a negative annual average growth rate (AAGR) of –1.2%. Figure 8.1 shows the final energy demand by sector in the LCET scenario. The transport sector shows the fastest decreasing rate at –3.9% per year, followed by the industry sector at –1.2% per year. The share of final energy demand by sector shows a structural change from 2019. The share of transport is forecast to decrease, whilst the share of industry and 'others' sectors will slowly increase at first and decrease later. The share of non-energy sector will increase at a faster speed, reaching 47.2% in 2050.

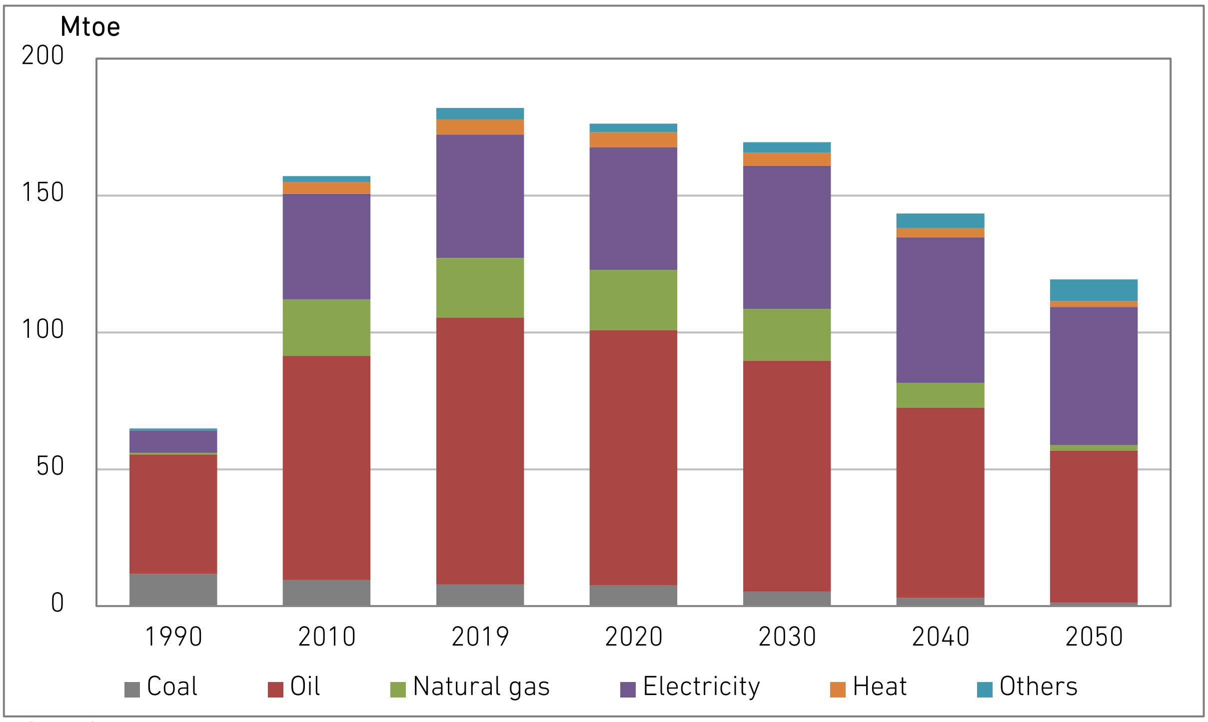
Final energy demand by source is shown in Figure 8.2. Oil will continue to be a dominant energy, accounting for 43.9% of its share, followed by electricity, 39.8%, hydrogen/ammonia, 5.7%, and natural gas, 1.6%. Coal will be marginalised at a share of 0.9% as a minor energy source for industrial, residential, and commercial use. Others such as biomass, heat, and other renewable energies, are expected to be increasing its share from 1.1% in 2019 to 2.3% in 2050.

Figure 8.1. Final Energy Consumption by Sector: LCET–CN Scenario




LCET–CN = low-carbon energy transition–carbon neutral, Mtoe = million tonnes of oil equivalent.
Source: Author's calculations.

Figure 8.2. Final Energy Consumption by Energy: LCET–CN Scenario




LCET–CN = low-carbon energy transition–carbon neutral, Mtoe = million tonnes of oil equivalent.
Source: Author's calculations.

## 3. Power Generation (historical trend: 2019, 2030, 2040, 2050)

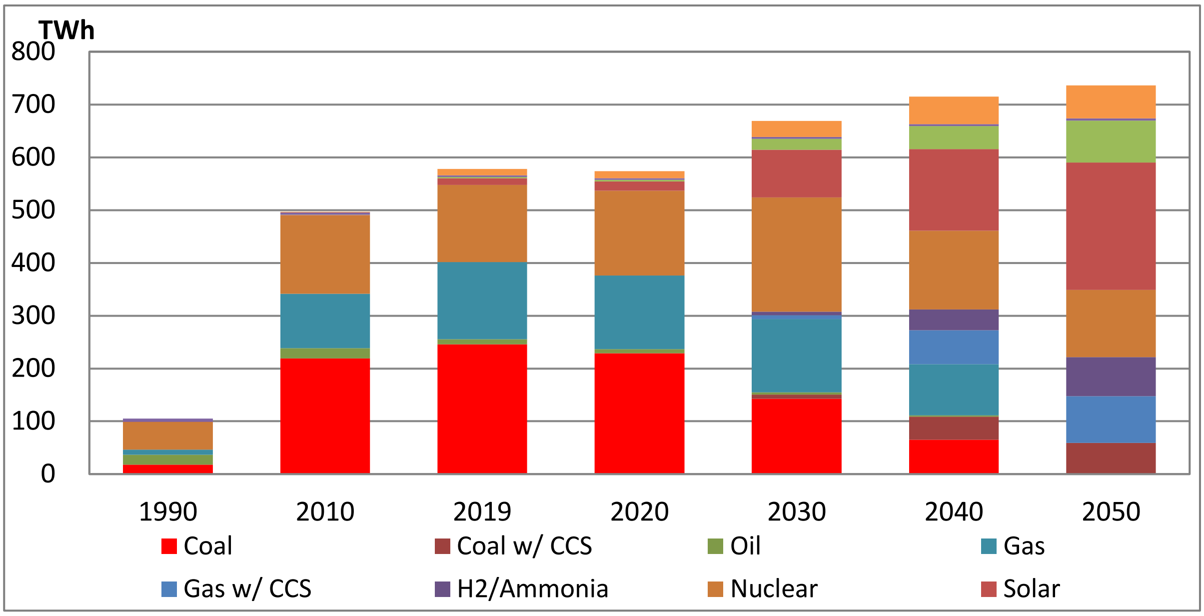
### Historical Trend

In 2019, electric power generation in the Republic of Korea amounted to 578.0 terawatt-hours (TWh), with coal providing nearly half of the country's electricity (42.6%), followed by natural gas at 25.3%, and nuclear power at 25.2%. Total electricity consumption grew at an AAGR of 6.0% between 1990 and 2019. When broken down by fuel type, coal increased at an annual rate of 9.5%, natural gas at 9.8%, and nuclear at 3.6% between 1990 and 2019. Over the same period, oil had a negative annual growth rate of –2.4% whilst hydro had –2.8%. Meanwhile, other energy sources such as new and renewable energy has grown rapidly, solar photovoltaic (PV) cells in particular, having grown amazingly fast at an annual rate of 32.8%.

### LCET–CN Scenario

As shown in Figure 8.3, electric power generation in the LCET–CN scenario is projected to increase from 578.0 TWh in 2019 to 736.1 TWh in 2050. In terms of fuel mix in the power generation, it is predicted that clean and carbon-free energy sources, such as solar PVs and wind power, will experience a rapid increase. Power generation by fossil fuels equipped with CCS will replace the existing power plants, resulting in 8.0% for coal and 12.1% for natural gas with a total of 20% in the LCET–CN scenario. The fuel mix is expected to include hydrogen, making up approximately 10% of the total. Other fuels, including nuclear and other renewables, are expected to hold higher shares in the fuel mix.

Figure 8.3. Power Generation by Energy Source: LCET–CN Scenario




CCS = carbon capture and storage, LCET–CN = low-carbon energy transition–carbon neutral, TWh = terawatt-hour.
Source: Author's calculations.

## 4. Primary Energy Supply

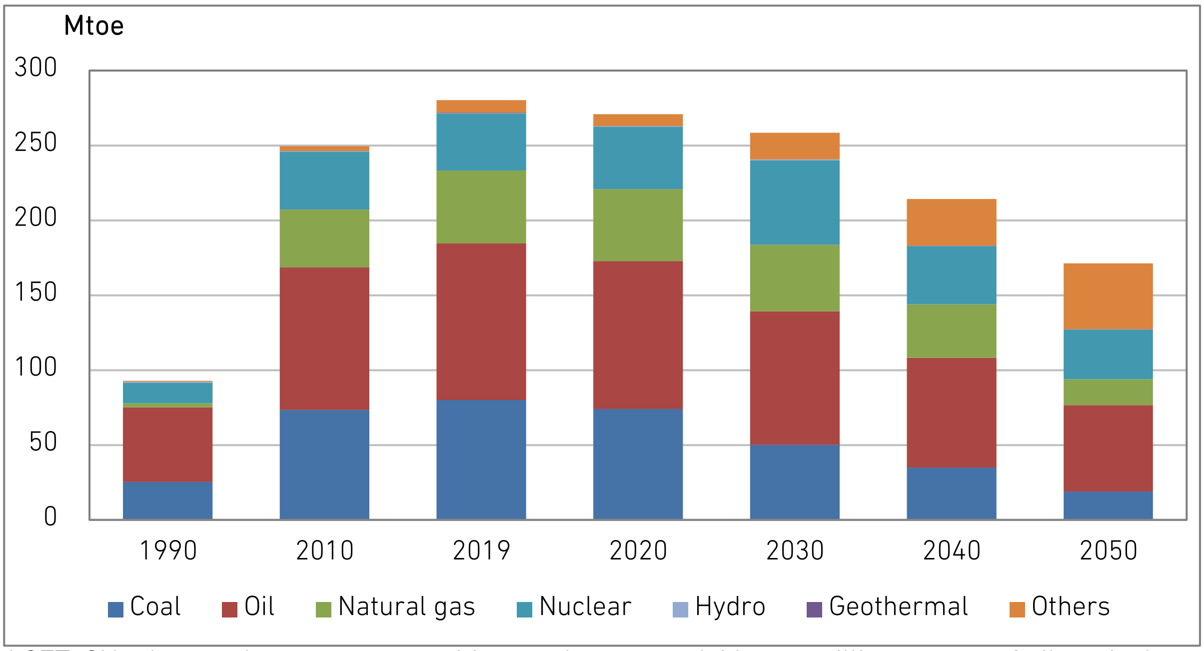
### Historical Trend

Primary energy demand in the Republic of Korea had increased at an AAGR of 4.2%, from 92.9 Mtoe in 1990 to 280.2 Mtoe in 2019. Amongst the major energy sources, natural gas grew the fastest at an average annual rate of 10.5%. The next was coal (4.0%), followed by nuclear (3.6%) and oil (2.6%) over the same period. Other energy sources, mainly renewable energy such as solar, wind, biomass, and ocean energy, have been rapidly growing at a rate of 8.7% over the same period. This indicates that the government has been successfully implementing its 'Low Carbon Green Growth' and 'Energy New Industry' policies initiated by the previous two administrations.

### LCET«CN Scenario

In the LCET–CN scenario, primary energy supply is projected to decrease at an AAGR of –1.4% per year from 280.2 Mtoe in 2019 to 180.3 Mtoe in 2050. Consumption of fossil fuels, such as coal, oil, and nuclear will gradually decrease in 2019–2050, whereas that of clean energy such as hydro and new and renewable energy will increase by 1.1% and 5.5% per year, respectively, over the projection period (Figure.8.4). Aggressive implementation of energy efficiency and conservation measures on the demand side, along with a larger uptake of renewable energy on the supply side along with accelerated adoption of CCS in power generation by coal and gas, will be the major contributors to reduced fossil fuel consumption.

Figure 8.4. Total Primary Energy Supply: LCET–CN Scenario




LCET–CN = low-carbon energy transition–carbon neutral, Mtoe = million tonnes of oil equivalent.
Source: Author's calculations.

## 5. Carbon Dioxide Emissions

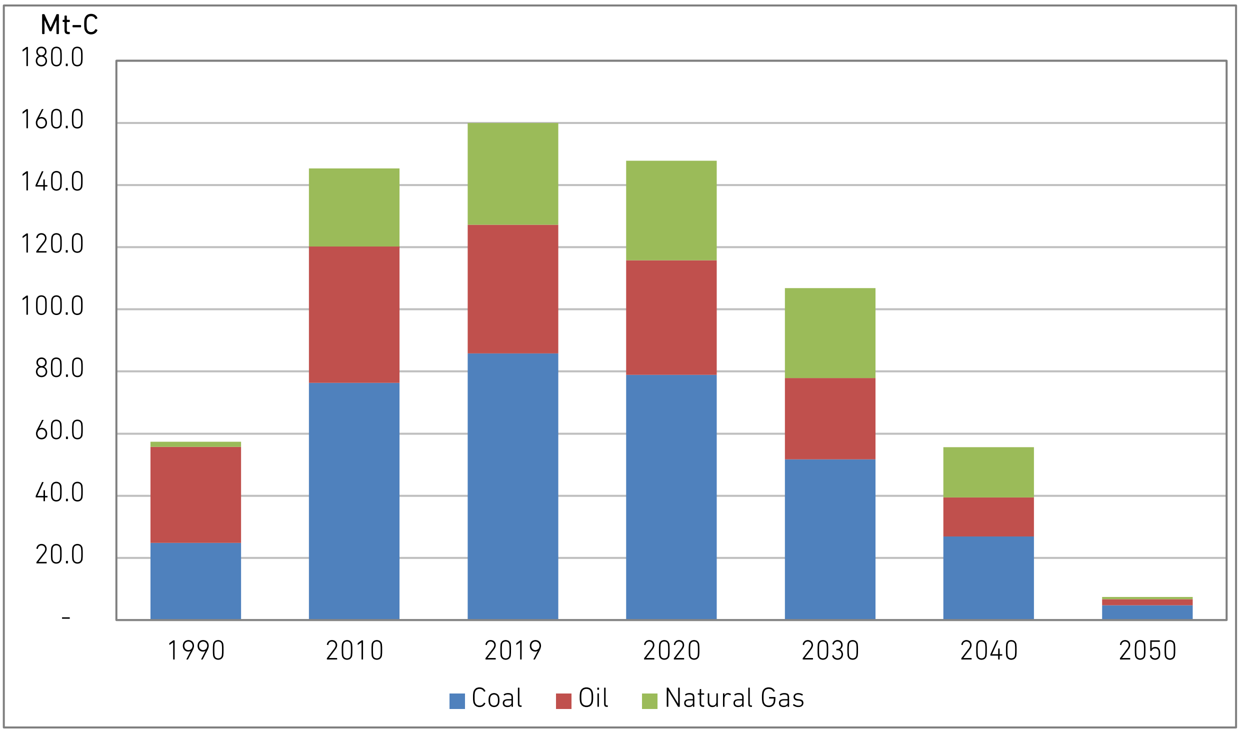
### Historical Trend

Carbon dioxide ($CO_2$) emissions from energy consumption had increased at an AAGR of 3.6%, from 57.4 $CO_2$ in 1990 to 497.0 million tonnes of carbon (Mt-C) in 2019 due to the continuous increase in fossil fuel consumption during the same period, which used to be explained in terms of coupling between economic growth and energy consumption. Amongst fossil fuels, coal contributes most at 53.6%, oil, 25.9%, and natural gas, 20.5% in the total $CO_2$ emissions.

### LCET–CN Scenario

$CO_2$ emissions from energy consumption in the LCET–CN scenario are projected to abruptly decrease at an AAGR of –10.4%, from 160.0 Mt-C in 2019 to 5.3 Mt-C in 2050 as shown in Figure 8.5. Such a negative growth rate is much lower than that of primary energy consumption which is estimated to be –1.4% per year. This indicates that the Republic of Korea will be using less carbon-intensive fuels – such as nuclear, natural gas, and renewable energy – and employing more energy-efficient green technologies. To attain such an ambitious target, the government must develop and implement cost-effective and consensus-based action plans to save energy and reduce $CO_2$ emissions.

Figure 8.5. $CO_2$ Emissions: LCET–CN Scenario




LCET–CN = low-carbon energy transition–carbon neutral, Mt-C = million tonnes of carbon.
Source: Author's calculations.

## 6. Hydrogen Demand across Sectors

Hydrogen is regarded as an energy carrier, playing a key role in energy transition to a future sustainable energy system. The Republic of Korea is no exception in this global trend, it is promoting a large uptake of hydrogen across the sector. One of the key elements of the 2050 Vision of 2050 Carbon Neutrality Strategy is expanding the use of clean power and hydrogen across all sectors.

The Republic of Korea's hydrogen industry is growing rapidly, and in 2021, about 2.4 million tonnes of hydrogen were produced, 53.3% of which was grey hydrogen and 46.6% by-product hydrogen. The goal of domestic clean hydrogen production technology is to develop and indigenise systems, improve alkaline and polymer electrolyte membrane (PEM) water electrolysis, design development of water electrolysis stacks and systems, and research and development of future hydrogen production technologies.

In the logistics sector, policy directions are focused on infrastructure building including hydrogen distribution and charging stations. Hydrogen is being delivered using hydrogen tube trailers – currently there are about 950 hydrogen tube trailers in operation in the Republic of Korea. There are 244 hydrogen charging stations nationwide, with a focus on hydrogen distribution and charging infrastructure development. In the distribution and storage sector, infrastructure development for the overseas introduction of clean hydrogen is underway, and a pilot plant demonstration project for ammonia-based clean hydrogen production is also underway.

The Republic of Korea's 'Hydrogen Economy Revitalization Roadmap' was initially centred on the hydrogen car and hydrogen fuel cell industries, and as of May 2023, 32,168 hydrogen cars had been supplied. By the end of May 2023, about 917.21 megawatts (MW) of power generation fuel cells were supplied in the field of power generation fuel cells, and steady growth was achieved. In the hydrogen utilisation sector, mobility technology development, hydrogen power generation technology development, and infrastructure construction projects are the main areas, and ammonia-based clean hydrogen power generation and hydrogen hybrid power generation demonstration projects using gas turbines are underway. Technology goals include improving the fuel economy and durability of hydrogen vehicles, developing fuel cell capacity and repackaging technology for large-scale mobility, and developing technologies for hydrogen railways, hydrogen ships, and drone fuel cell systems. It is also planned to develop technology for direct hydrogen combustion technology and to build a power generation system using hydrogen and ammonia.

Table 8.1. Hydrogen Roadmap: Targets

| | | 2018 | 2022 | 2040 |
|---|---|---|---|---|
| Hydrogen Vehicles<br>(Export)<br>(Domestic) | | **1.8 thousand**<br>(0.9 thousand)<br>(0.9 thousand) | **81 thousand**<br>(14 thousand)<br>(67 thousand) | **6,200 thousand**<br>(3,300 thousand)<br>(2,900 thousand) |
| Fuel Cells | Power Generation<br>(Domestic) | **307 MW**<br>(total) | **1.5 GW**<br>(total) | **307 MW**<br>(total) |
| | Residential/Buildings | **7 MW** | **7 MW** | **7 MW** |
| Hydrogen supply | | 130 thousand/year | 470 thousand/year | 5,260 thousand/year |
| Hydrogen price | | - | W6,000/kg | W3,000/kg |

GW = gigawatt, kg = kilogramme, MW = megawatt.
Source: MOTIE (2019).

The Republic of Korea has set a goal of supplying about 470,000 tonnes of hydrogen per year in 2022, about 1.94 million tonnes per year in 2030, and more than 5.26 million tonnes per year in 2040. In the Hydrogen Economy Revitalization Roadmap in 2019, a supply plan was established in consideration of all forms of hydrogen, including by-product hydrogen and grey hydrogen. The supply of hydro electrolytic hydrogen will begin in 2022, and from 2030 the supply of hydro electrolytic hydrogen and hydrogen produced abroad will be expanded (Table 8.2).

Table 8.2. Hydrogen Production

| | 2018 | 2022 | 2030 | 2040 |
|---|---|---|---|---|
| Supply (=demand) | 130 thousand ton/year | 470 thousand ton/year | 1,940 thousand ton/year | >5,260 thousand ton/year |
| Hydrogen production | ① By-product $H_2$<br>② Reformed $H_2$ | ① By-product $H_2$<br>② Reformed $H_2$<br>③ Electrolysis | ① By-product $H_2$<br>② Reformed $H_2$<br>③ Electrolysis<br>④ Overseas Production<br>※①+③+④: 50%<br>②: 50% | ① By-product $H_2$<br>② Reformed $H_2$<br>③ Electrolysis<br>④ Overseas Production<br>※ ①+③+④: 50%<br>②: 30% |
| Hydrogen price | -<br>(policy pricing) | W6,000/kg<br>(initial market price) | W6,000/kg | W3,000/kg |

$H_2$ = hydrogen, kg = kilogramme.
Source: MOTIE (2019).

## 7. Energy Cost Comparison between BAU and LCET–CN Scenarios

This section conducts an analysis on energy cost in order to compare the cost difference between the business as usual (BAU) and LCET–CN scenarios. This analysis enables us to estimate the total investment cost in implementing policies and programmes under the LCET–CN scenario in comparison with the BAU scenario. The basic assumptions for this analysis are shown in Table 8.3.

Table 8.3. Assumptions for Fuel Costs

| Energy Source (units) | 2019/2020 | 2050[1)] |
|---|---|---|
| Coal (US$/tonne) | 80.03 | 98.00 |
| Oil (US$/bbl) | 41 | 100 |
| Gas (US$/MMBtu) | 7.77 | 7.50 |
| Hydrogen (US$/$Nm^3$) | 0.8 | 0.3 |
| CCS (US$/$CO_2$ tonne) | 0 | 30 |

CCS = carbon capture and storage, bbl = barrel, MMBtu = metric million British thermal unit, $Nm^3$ = normal cubic metre.
Note: [1)] 2019 constant price.
Source: Author's calculations.

Table 8.4. Assumptions for Construction Cost of Power Plants
(US$/KW)

| Fuel Source | 2019/2020 | 2050[1)] |
|---|---|---|
| Coal | 1,500 | 1,525 |
| Oil | 41 | 100 |
| Gas | 7.77 | 700 |
| Hydrogen | 0.8 | 700 |
| Nuclear | 4,500 | 3,575 |
| Hydro | 2,000 | 2,223 |
| Geothermal | 4,000 | 4,256 |
| Solar | 1,600 | 307 |
| Wind | 1,600 | 1,235 |
| Biomass | 2,000 | 3,019 |

KW = kilowatt.
Note: [1)] 2019 constant price.
Source: Author's calculations.

Table 8.5. Assumptions for Capacity Factors of Power Plants

(%)

| Fuel Source | 2019/2020 | 2050[1] |
|---|---|---|
| Coal | 75 | 80 |
| Oil | 75 | 80 |
| Gas | 75 | 80 |
| Hydrogen | 0 | 80 |
| Nuclear | 100 | 80 |
| Hydro | 50 | 40 |
| Geothermal | 50 | 50 |
| Solar | 17 | 17 |
| Wind | 40 | 40 |
| Biomass | 50 | 70 |

Note: [1] 2019 constant price.
Source: Author's calculations.

### 7.1. Fuel Cost

Based on fuel costs assumed for each of energy source in Table 8.1, total investment fuel cost was calculated as shown below in Table 8.6. Primary energy consumption in the LCET–CN scenario will be 102.8 Mtoe which is much lower than that of BAU scenario at 102.8 Mtoe. Consequently, the total investment fuel cost in 2050 in the LCET–CN scenario is estimated to be US$51,141 million, which is a lot lower than that under the BAU scenario at US$89,219 million.

Table 8.6. Total Investment by Energy Source, BAU vs LCET–CN Scenarios

| | Primary Energy Consumption (Mtoe) | | | Total Investment (US$ million) | |
|---|---|---|---|---|---|
| | BAU | | LCET–CN | BAU | LCET–CN |
| | 2019 | 2050 | 2050 | 2050 | 2050 |
| Coal | 80.04 | 62.89 | 18.93 | 9,939 | 2,992 |
| Oil | 104.43 | 85.80 | 57.75 | 59,017 | 39,722 |
| Gas | 48.87 | 69.76 | 17.16 | 20,145 | 4,956 |
| Hydrogen | 0.0 | 0.31 | 8.94 | 119 | 3,472 |
| **Total** | **233.34** | **218.77** | **102.79** | **89,219** | **51,141** |

BAU = business as usual, LCET–CN = low-carbon energy transition–carbon neutral, Mtoe = million tonnes of oil equivalent.
Source: Author's calculations.

### 7.2. Power Generation Investment

Based on assumptions for power generation investment shown in Table 8.4 and Table 8.5, the total investment cost for power plants was calculated in 2050 for BAU and LCET–CN scenarios shown in Table.8.7. As shown in Table 8.7, the total additional capacity required by 2050 under the BAU scenario is 38,343 MW since 2019. However, the additional capacity under the LCET–CN scenario is estimated to be 160,963 MW which is much bigger than that under the BAU scenario. This is due to more aggressive uptake of renewable energy (RE) for power plant in 2050 under the LCET–CN scenario in pursuit of greater reduction in $CO_2$ emissions. Accordingly, the total investment for power plants in 2050 under the BAU scenario is estimated to be US$26,081 million whereas it is estimated to be US$30,744 million under the LCET–CN scenario.

Table 8.7. Total Investment in Power Plants, BAU vs LCET–CN Scenarios

| | Primary Energy Consumption (TWh) | | | Additional Capacity (MW) | | Total Investment (US$ million) | |
|---|---|---|---|---|---|---|---|
| | BAU | | LCET–CN | BAU | LCET–CN | BAU | LCET–CN |
| | 2019 | 2050 | 2050 | 2050 | 2050 | 2050 | 2050 |
| Coal | 246.07 | 234.48 | 58.89 | –1764 | –28,490 | 0 | 0 |
| Oil | 9.30 | 0.12 | 0.00 | –1398 | –1,416 | 0 | 0 |
| Gas | 146.10 | 303.40 | 88.82 | 23,943 | –8,717 | 16,760 | 0 |
| Hydrogen | 0.00 | 0.00 | 73.61 | 0 | 11,204 | 0 | 7,843 |
| Nuclear | 145.91 | 68.30 | 127.32 | –11,075 | –2,653 | 0 | 0 |
| Hydro | 2.83 | 3.56 | 3.88 | 138 | 200 | 307 | 444 |
| Geothermal | 0.00 | 0.00 | 0.00 | 0 | 0 | 0 | 0 |
| Solar | 13.00 | 48.94 | 241.58 | 24,133 | 153,492 | 7,409 | 47,122 |
| Wind | 2.68 | 15.90 | 79.57 | 5,032 | 29,257 | 6,214 | 36,133 |
| Biomass | 9.32 | 14.12 | 62.45 | 731 | 8,086 | 2,207 | 24,413 |
| **Total** | **575.20** | **688.82** | **736.11** | **38,343** | **160,963** | **32,897** | **115,955** |

BAU = business as usual, LCET–CN = low-carbon energy transition–carbon neutral, MW = megawatt, TWh = terawatt-hour.
Source: Author's calculations.

### 7.3. Carbon Capture and Storage Cost

Power generation, fuel consumption, and investment cost for CCS were calculated for power generation by coal-fired and natural gas-fired power plants equipped with CCS. Assuming that CCS devices can capture up to 90% of $CO_2$ emissions and the average cost of capture is about US$30/$CO_2$ ton, the total investment for CCS is estimated to be

US$3,257 million for coal-fired power plants and US$1,947 million for gas-fired, respectively, with a total of US$5,204 (Table 8.8).

Table 8.8. Total Investment for CCS under LCET–CN Scenario in 2050

| | Power Generation (TWh) | Fuel Consumption (Mtoe) | $CO_2$ Emissions ($Mt\text{-}CO_2$) | $CO_2$ Emissions (Mt-C) | Total Investment (US$ million) |
|---|---|---|---|---|---|
| Coal-fired Power Plant | 58.89 | 13.85 | 51.70 | 14.09 | 3,257 |
| Gas-fired Power Plant | 88.82 | 14.51 | 30.91 | 8.42 | 1,947 |
| Total | **147.71** | **28.36** | **82.61** | **22.51** | **5,204** |

CCS = carbon capture and storage, LCET–CN = low-carbon energy transition–carbon neutral, Mtoe = million tonnes of oil equivalent, Mt-C = million tonnes of carbon, $Mt\text{-}CO_2$ = million tonnes of carbon dioxide equivalent, TWh = terawatt-hour.
Source: Author's calculations.

### 7.4. Overall Cost

Based on the above calculation results, it is possible to compare total costs between the LCET–CN and the BAU scenarios as shown in Table 8.9. Overall investment cost under the BAU scenario in 2050 is projected to be US$90,280 million, whilst the investment cost in the LCET–CN scenario is estimated at US$60,086 million. This result indicates that the total investment in the LCET–CN scenario will save 33.5% of that amount in the BAU scenario, amongst which fuel cost contributes more than 100% to the cost savings in the LCET–CN scenario.

Table 8.9. Cost Comparison: BAU vs LCET–CN Scenarios in 2050 (US$)

| | BAU | LCET–CN | LCET–CN vs BAU |
|---|---|---|---|
| Fuel Cost | 89,219 | 51,141 | –38,078 |
| Power Capital Cost | 1,061 | 3,740 | 2,679 |
| CCS | 0 | 5,204 | 5,204 |
| **Total** | **90,280** | **60,086** | **–30,194** |

BAU = business as usual, CCS = carbon capture and storage, LCET–CN = low-carbon energy transition–carbon neutral.
Source: Author's calculations.

## 8. Conclusions and Policy Recommendations

Up to now, starting with a series of assumptions on fuel costs and construction costs as well as capacity factors of power plants by energy source, investment costs under the BAU and the LCET–CN scenarios were calculated and compared with each other in terms of primary energy supply, power generation, and CCS.

### Conclusions

The total investment cost of the LCET–CN scenario is estimated to be US$60,086 million, which is lower compared to that in the BAU scenario at US$90,280 million, which indicates that the Republic of Korea will be able to attain the target of net zero by 2050 by implementing all policy measures available under the LCET–CN scenario. In addition, it will lead to reduction in the total investment by US$30,194 million as compared to that in the BAU scenario in the energy sector alone.

Amongst investment costs, only the fuel cost, sharing a major portion, 85.1% is estimated to be reduced by US$38,07 million which covers more than increases in power capital cost and CCS. This indicates that fuel cost is critical in terms of share and capital investment. Investment in CCS is estimated to reach US$5,204 million in 2050, with a share of 8.7% in the total investment. If more policy efforts are taken along with technological advancements, the investment cost of CCS is expected to be reduced by a big margin.

### Policy Recommendations

As the worldwide economy is quickly entering into a transition to respond to the climate crisis, the importance of climate issues has emerged in the context of strengthening global industrial competitiveness. Under international pressure, in response to the Paris Agreement, the government of the Republic of Korea established the 2030 Nationally

Determined Contribution in June 2015 and prepared the Basic Roadmap for Achieving the 2030 Nationally Determined Contribution at the end of 2016, which embodied the implementation of the goal. As a follow-up to this initiative, specific implementation measures for each sector were presented to achieve the goals, such as the Carbon Neutral Technology Innovation Implementation Strategy (MSIT, 2021) and the Carbon Neutral Industry and Energy R&D Strategy (MOTIE, 2021).

Energy transition and carbon neutrality are becoming an irreversible global trend. The government is currently proactively implementing the Energy Transition, Carbon Neutral, and Green New Deal policies and the Hydrogen Economy Revitalization Roadmap. In this context, the LCET–CN scenario indicates an ambitious $CO_2$ reduction target compared to the BAU scenario. Investment costs show a big margin between the BAU and LCET–CN scenarios, calling for an exceptional effort in policy development and implementation. The government must develop and implement cost-effective and nation-wide consensus-based action plans to reduce $CO_2$ emissions by a huge margin. The government should take a more balanced approach in response to addressing the LCET–CN scenario, reviving nuclear power by abandoning the previous denuclearisation policy. It is also necessary to continue the hydrogen economy and Renewable Energy 3020 along with fossil fuels with CCUS.

## References


Ministry of Trade, Industry, and Energy (MOTIE) (2019), *Hydrogen Economy Revitalization Roadmap.*

______ (2021), *Carbon Neutral Industry and Energy R&D Strategy.*